Plum and Fresh Prune

Carlos H. Crisosto and Adel A. Kader
Pomology Department, University of California, Davis, CA

Scientific Name and Introduction: Plums (*Prunus salicina*) are mainly marketed for fresh consumption and not for drying. They are also used for canning, freezing, and jam and jelly making. The Japanese plum is native to China, but was domesticated in Japan 400 years ago. It was first brought to California from Japan in 1870 by John Kelsey. In 1885, Luther Burbank imported about 12 seeds from Japan, and used them to breed many cultivars. The plum industry has increased throughout California (mainly in the central San Joaquin Valley) where most Japanese plums in the U.S. are grown.

Prunes are cultivars of European Plum (*Prunus domestica*, L.) which can be dried whole. Like plums, prunes can be eaten fresh (if a very sweet fruit is desired); but they also have the high sugar content necessary for successful drying. The European Plum, believed to have originated in the Near East, has been grown in parts of Europe for many centuries. Through it's culture in France, the prune 'd'Agen' was introduced to California from France by Louis Pellier, a French horticulturist who had come to California seeking gold.

Quality Characteristics and Criteria: High consumer acceptance is attained for fruit with high SSC. Fruit TA, SSC:TA and phenolic content (astringency) are also important factors in consumer acceptance. However, there is no established minimum quality standard based on these factors. Plums with about 10 N (1 kg-force) flesh firmness (8-mm tip) are considered ready-to-eat.

Horticultural Maturity Indices: In most of the plum cultivars grown in California, harvest date is determined by skin color changes that are described for each cultivar. A color chip guide is used to determine maturity for some cultivars. Firmness, measured by squeezing fruit in the palm of the hand ("spring"), is also a useful maturity index for a few cultivars.

A two tier maturity system is currently used in California: U.S. Mature (minimum maturity); and California Well-Mature. Measurement of fruit firmness is recommended for plum cultivars where skin ground color is masked by full red or dark color development before maturation. Flesh firmness, measured using a penetrometer (8-mm tip), can be used to determine a maximum maturity index, which is the stage at which fruit can be harvested without suffering bruising damage during postharvest handling. Plums are less susceptible to bruising than most peach and nectarine cultivars at comparable firmness.

Fresh prunes are picked on the basis of color, ie., at least 50% of the fruit surface is red or purple and SSC is at least 16% in 'Moyer' and 19% in 'French' prunes.

Grades, Sizes and Packaging: Plums and fresh prunes are hand-picked into bags, then dumped in bins that are moved on trailers between tree rows in the orchard. At the packinghouse, plums are dumped (mostly using dry bin dumps) and washed. Sorting is done to eliminate fruit with visual defects and sometimes to divert fruit of high surface color to a high-quality pack. Sizing segregates fruit either by weight or dimension. In general, plums and fresh prunes are packed into 12.6 kg (28 lb) volume-filled containers.

Pre-cooling Conditions: Plums and fresh prunes can be cooled in field bins using forced-air cooling, hydro-cooling, or room-cooling prior to packing. Packed plums and fresh prunes should be cooled by forced-air cooling to near 0 °C.

Optimum Storage Conditions: A storage temperature of -1.1 to 0 °C (30 to 32 °F) with 90 to 95% RH should be used. An air circulation velocity of approximately 15 m^3/min is suggested. The freezing point

varies from -2 to -1 °C (28.4 to 30.2 °F) depending on SSC.

In late season plums and in fresh 'French' and 'Moyer' prunes, delays in internal breakdown (IB) development have been attained by storing IB-susceptible cultivars at -1.1 °C (30 °F). However, to store fruit at this low a temperature, high SSC and excellent thermostatic control are essential to avoid freeze damage.

Controlled Atmosphere (CA) Considerations: The major benefits of CA during storage and shipment are retention of fruit firmness and delay of changes in ground color. Decay incidence is reduced by CA of 1 to 2% O_2 + 3 to 5 % CO_2. Currently, CA has a limited use for storage > 1 mo with some cultivars such as Angeleno, Casselman, Santa Rosa, Laroda and Queen Ann.

Retail Outlet Display Considerations: If fruit firmness is < 22 N (2.3 kg-force; 5 lb-force), plums should be displayed on a cold table. If fruit firmness is > 22 N (2.3 kg-force; 5 lb-force), fruit should be displayed on a dry table.

Chilling Sensitivity: Postharvest life varies among cultivars and it is strongly affected by temperature management. Most plum and fresh prune cultivars are susceptible to chilling injury when stored at 5 °C (41 °F). Market-life of 'Blackamber,' 'Fortune' and 'Angeleno' plums at 0 °C (32 °F) was > 5 weeks. 'Show Time,' 'Friar,' and 'Howard Sun' plums developed chilling injury symptoms within 4 weeks, even when stored at 0 °C (32 °F). In all plum cultivars, a much longer market-life was achieved when stored at 0 °C (32 °F) than at 5 °C (41 °F).

Ethylene Production and Sensitivity: Rates are 0.01 to 5 μL kg^{-1} h^{-1} at 0 °C; 0.02 to 15 μL kg^{-1} h^{-1} at 5 °C; 0.04 to 60 μL kg^{-1} h^{-1} at 10 °C and 0.1 to 200 μL kg^{-1} h^{-1} at 20 °C. The lower end of this range is for mature but unripe fruit; higher values are for ripe fruit.

Most plums harvested at the California Well-Mature stage (higher than U.S.-Mature stage) will ripen properly without exogenous ethylene. However, for slow ripening cultivars, such as Black Beaut, Casselman, Late Santa Rosa, Kelsey, Nubiana, Queen Ann and Roysum, application of 100 μL L^{-1} for at least 24 h at 20 °C (68 °F) is needed for faster and more uniform ripening.

Respiration Rates:

Temperature	mg CO_2 kg^{-1} h^{-1}
0 °C	2 to 3
10 °C	8 to 12
20 °C	16 to 24

To get mL kg^{-1} h^{-1}, divide the mg kg^{-1} h^{-1} rate by 2.0 at 0 °C (32 °F), 1.9 at 10 °C (50 °F), and 1.8 at 20 °C (68 °F). To calculate heat production, multiply mg kg^{-1} h^{-1} by 220 to get BTU per ton per day or by 61 to get kcal per metric ton per day.

Physiological Disorders: Chilling injury (CI) is a concern with most plum and fresh prune cultivars. It is expressed as flesh translucency associated with flesh browning. Late plum cultivars also develop lack of juiciness in addition to these symptoms. In previous publications from South Africa, flesh translucency, specifically in some plum cultivars, has been called gel breakdown (Dodd, 1984). In the U.S., these symptoms are reported under internal breakdown or CI (Crisosto et al., 1999; Mitchell and Kader, 1989). CI symptoms normally appear after placing fruit at ripening temperatures following cold storage at 2 to 8 °C (35.6 to 46.4 °F).

Internal browning is a physiological disorder of 'Italian' and other cultivars of prunes that originates before harvest. It is associated with high temperatures during fruit maturation and delayed harvest.

Postharvest Pathology: Brown rot is caused by *Monilia fructicola* and is the most important postharvest disease of stone fruits. Infection begins during flowering. Fruit rot may occur before harvest, but often occurs during postharvest handling. Orchard sanitation to minimize infection sources, pre-harvest fungicide application and prompt pre-cooling after harvest are control strategies. Fruit cracking makes late season cultivars more prone to decay. Postharvest fungicide treatments may be used to limit decay.

Gray mold is caused by *Botrytis cinerea*. This rot can be serious during wet, Spring weather. It can occur during storage if fruit have been contaminated through harvest and handling wounds. Avoiding mechanical injuries, effective temperature management and postharvest fungicide treatments are effective control measures.

Rhizopus rot is caused by *Rhizopus stolonifer*. This rot can occur in ripe or near-ripe stone fruits kept at 20 to 25 °C (68 to 77 °F). Pre-cooling fruit and storing them below 5 °C (41 °F) is effective in controlling this fungus.

Quarantine Issues: A phytosanitary certificate is required to import California plums into Taiwan. Plums must be free of *Anarsia lineatella* (peach twig borer), *Conotracherlus nenuphar* (plum curculio), *Cydia pomonella* (codling moth), *Erwinia amylovora* (fire blight), *Rhagoletis pomonella* (apple maggot), *Tetranychus pacificus* (Pacific spider mite) and *Ceratitis capitata* (Mediterranean fruit fly). If these conditions can not be met, fruit must be treated appropriately prior to shipment. Details of the treatment must be recorded on the phytosanitary certificate.

A phytosanitary certificate is required to import California plums into British Columbia, Canada. The certificate should claim that fruit is free of *Cydia molesta* (oriental fruit moth) and it should be clearly advertised that the fruit in the shipment were produced and inspected in accordance with the "systems approach guidelines" agreed to by APHIS and the CFIA. Fruit imports are unrestricted to all of the other Canadian provinces.

A similar systems approach, between APHIS and SAGAR/CONASAG/DGSV was established with Mexico to facilitate import and assure plums are free of *Cydia molesta* (oriental fruit moth), *Conotracherlus nenuphar* (plum curculio), *Rhagoletis pomonella* (apple maggot), and fruit flies (*Tephritidae*).

Suitability as Fresh-cut Product: Fresh-cut plums are best kept at 0 °C (32 °F) in packages that minimize water loss. Fresh-cut marketing life ranges from 2 to 5 days, depending on cultivar and stage of ripeness (firmness) at the time of slicing.

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Acknowledgments: Some of the information included was from the University of California - Davis website on Fresh Produce Facts at http://postharvest.ucdavis.edu/produce/producefacts.